The Value of Repeated Chest X-Ray in Intensive Care Units

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ABSTRACT

Background: Routine daily chest X-rays (RXR) are now replaced by an on-demand radiographic policy to decrease the hazards of radiation and avoid unnecessary movements of patients. However, this may miss possible serious conditions in critical patients. Repeated X-rays at patient admission, may be needed to help follow up of patient's condition and avoid misdiagnosis.

Objectives: This study aimed to determine the major radiological abnormalities of the repeated chest x-ray and their impact on the management of intensive care unit (ICU) patients.

Methods: A prospective study was conducted on 110 patients in ICU and/or mechanically ventilated (74 adult and 36 pediatric) at The Adult and Paediatric ICU in Menoufia University Hospital through the period from January 2021 to March 2022.

Results: The most common initial radiographic findings among the studied cases were consolidations (n=26 / 23.62%) and pleural effusion (n=25 / 22.7%). On release, most of the studied cases showed improvement (n=40/ 36.36%). After line placement, consolidation was the most common chest X-ray finding (n=26 /23.6%) and on the second follow-up (n=24/ 21.8%). The most common clinical approach among the studied cases was requesting further advanced imaging techniques (CT chest, CT pulmonary angiography & chest US), (n=40/47.62%), followed by no change in management plan (drug therapy) that was found in 30 cases (35.71%)**.** Furthermore, 84 patients showed improvement of clinical condition in the ICU and were released either to the intermediate ward, to a medical department or to complete treatment at home. 58 of them were still showing consolidation (69.06%), 10 patients (11.90%) showed effusion, and 16 patients (19.05%) showed atelectasis.

Conclusions: The repeated radiographic evaluation of patients in ICU is initial to monitoring devices used because the potentially serious complications arising from their introduction and use are often not clinically apparent. Also, repeated chest x-rays are helpful to detect other serious chest conditions that may be missed during patients' follow-ups. Chest x-ray before the patient's release helps in expecting the patient's condition and avoiding any unexpected problems after the patient's release.

Keywords: Chest x-ray, ICU, Pneumonia, Pneumothorax, Radiological abnormalities.

INTRODUCTION

A vital component of the initial evaluation and daily monitoring of critically sick patients is chest radiography [1]. Critical radiological abnormalities that may necessitate urgent action must frequently be promptly and accurately identified in cases of sudden clinical deterioration. On the other hand, a misdiagnosis or misinterpretation may result in therapy that is incorrect, delayed, or even dangerous, putting the critically sick patient at increased risk of worsening [2].

Any medical device may be subjected to coiling, kinking, misposition, fracture, or malfunction. The resulting problems are sometimes not immediately evident in clinical settings. In order for the doctor or surgeon to repair or realign these devices, it is crucial to find them on the immediate post-procedural CXR or follow-up CXRS [3].

The American College of Radiology advises immediate imaging for all patients who had endotracheal tubes, feeding tubes, vascular catheters and chest tubes placed. Also, daily chest radiography for critically ill patients with acute cardiopulmonary disease or on mechanical ventilation [4].

For early monitoring, identification and management, chest X-rays continue to be the gold standard diagnostic imaging method for detecting postoperative pulmonary problems in the ICU, including atelectasis, pneumonia, and pulmonary edema**.** Chest radiography is the usual method for determining the placement of lines, tubes, and catheters in the treatment of juvenile respiratory disorders that necessitate intensive care unit admission. It is also essential for the first detection of significant clinical changes in the respiratory profile [5]. So, this study aimed to determine the major radiological abnormalities of repeated chest X-rays and their impact on the management of ICU patients.

PATIENTS AND METHODS

A prospective study involved 110 patients in intensive care unit and or mechanically ventilated (74 adult and 36 pediatric) at Adult and Pediatric Intensive Care Units in Menoufia University Hospital through the period from January 2021 to March 2022.

Inclusion criteria: Adults and pediatric patients in ICU, mechanically ventilated patients, patients with inserted central venous lines, endotracheal intubation, chest tubes, and other devices.

Exclusion criteria: Neonates, unavailable clinical or laboratory data, non-diagnostic CXR image quality, and obese patients (Obesity: BMI is 30.0 or higher kg/m^2).

All patients were subjected to the following: Analysis of the clinical presentation. Initial chest X-ray, chest X-ray after device placement, repeated follow-up chest X-ray. And on release chest -x-ray. Released patients were 84, while lost cases on follow-up were 11 and arrested cases were 15. Chest x-ray: POSKOM. KOREA (Poskom 40 m) C-arm was used, 40 mA, 100Kv. X-ray films of the study cases were interpreted for: Lung pathology as consolidation, basal atelectasis, pneumothorax, pleural effusion, surgical emphysema, and chest wall hematoma. Type of devices (CVP, nasogastric tube, chest tube and endotracheal tube regarding positioning and complication).

Outcomes of the study: After the interpretation of images, we detected different pathologies, assessed the position of inserted lines and if complications after insertion occur. Follow-up chest X-ray films were assessed for improvement or deterioration of the patient's condition and decisions were taken for further assessment and/or management according to the patient's condition.

Ethical consideration: Menoufia Faculty of Medicine's Ethics Committee approved the study. All procedure were in compliance with the Declaration of Helsinki. Prior to their registration, each participant in this research was given a thorough description of its purpose, goals, and methods. The principal investigator was responsible for obtaining the participants' approval and written informed consent (IRB approval number: 8/2020RAD10).

Statistical analysis

SPSS version 25 was used on an IBM-compatible personal computer to collect, tabulate, and statistically analyze data. Descriptive statistics refer to the presentation of quantitative data as median and range. The Shapiro Walk test was used to determine if the data followed a normal distribution. Qualitative data was provided as frequencies and relative percentages.

RESULTS

In the current study, 110 patients participated in the study 74 of them were adults and 36 were pediatric (Figure 1). In our study, the mean age was 36.027 ± 22.21 and ranged from 13 to 60 years. In our study, Central venous pressure (CVP) was inserted in all (110) cases followed by the Nasogastric tube in 30 cases, then the Endotracheal tube in 28 cases, and Chest tubes in 15 cases (Table 1).
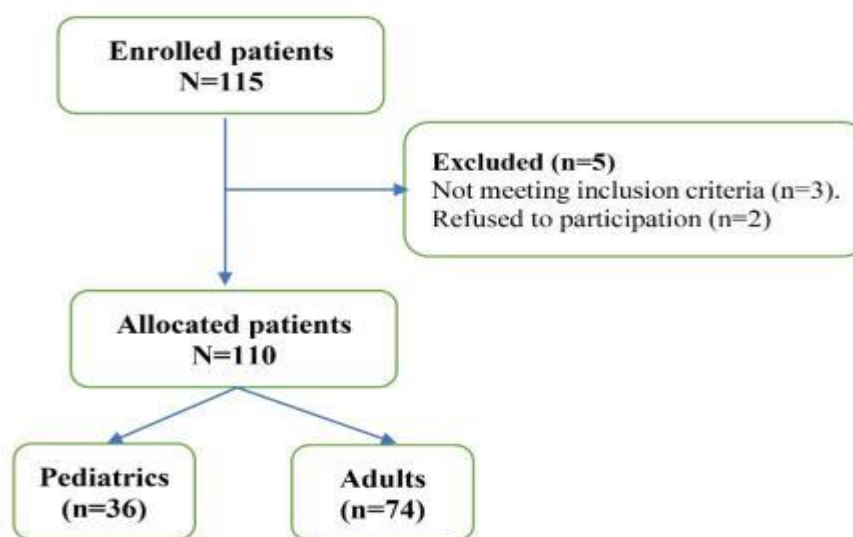

Figure (1): Flowchart of the study.

Table (1): Type of line inserted

Line inserted	CVP		Nasogastric tube		Chest tubes		Endotracheal tube	
	N	%	N	%	N	%	N	%
Number	110	100	30	35.7	15	17.8	28	33.33

Central venous pressure (CVP).

The most common initial radiographic finding among the studied cases were consolidations (n=26 / 23.62%) then pleural effusion (n=25 / 22.7%), followed by pneumothorax (n=21 / 19 %), atelectasis (n=14 / 12.7%), followed by pulmonary edema was found in 9 / 8.2%, (Table 2 & figure 2). While, after line placement, malposition of devices was found in 20 / 18.2 % of cases, consolidation was still the most chest X-ray findings by 26 / 23.62% and was the most common finding in second follow up (n=24 / 21.8%) (Table 2).

Table (2): Repeated x-ray chest findings

Chest X-Ray Findings	Immediate		After line placement		2nd follow-up		Other follow up	
	N*	%	N*	%	N**	%	N**	%
Malposition of devices	0	0	20	18.2	4	3.6	0	0.0
Other finding Consolidation	26	23.6	26	23.6	24	21.8	18	16.4
Pneumothorax	21	19	23	19	7	6.4	3	2.7
Pleural effusion	25	22.7	27	24.5	10	9	7	6.4
Atelectasis	14	12.7	14	12.7	11	10	20	18.2
Pulmonary edema	9	8.2	9	8.2	15	13.6	10	9
Suspected Pulmonary embolism	8	7.3	8	7.3	9	8.2	9	8.2
Subcutaneous emphysema	12	11	12	11	4	3.6	0	0

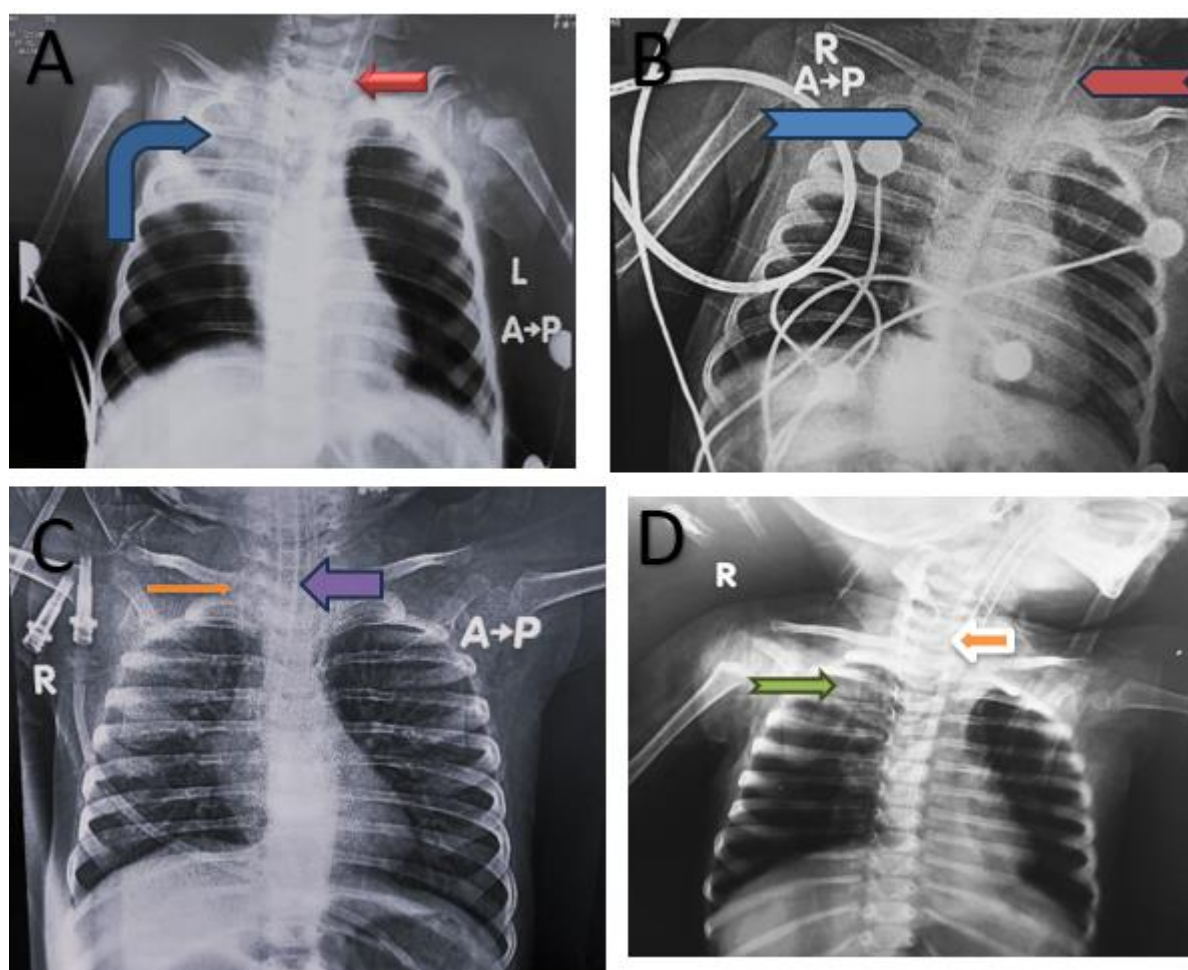*Overlap between findings,   **15 cases died and 11 lost follow up.

Figure (2): A 1-year-old child complaining of cough and granting with respiratory distress, 1st chest x-ray (A) Rt. Lung upper zone opacity (pneumonic patch) (blue arrow), ETT is seen relatively upwards (red arrow). 2nd x-ray (B) ETT is seen in place (red arrow), follow up (C) CVP line seen in place, last, follow up before ETT remove (D) residual lung consolidation (green arrow).

Most of the studied cases showed improvement (n=40/ 36.36%). Also, there were 19 cases showing progress (17.27%) in the form of pulmonary edema, atelectasis, and suspected pulmonary embolism, 15 cases died (13.64%) and 11 cases were lost follow up (10%), **(Table 3).**

Table (3): follow up among the studied cases (N=110).

	N	%
• Progress	19	17.27
• No change	25	22.73
• Improvement	40	36.36
• Died	15	13.64
• Lost follow up	11	10.00

In our study, the most common clinical approach among the studied cases was requesting further advanced imaging techniques (CT chest, CT pulmonary angiography, chest US), (Figure 3), (n=40/47.62%), followed by no change in management plan (drug therapy) found in 30 cases (35.71%), (Table 4 & figure 4).

Furthermore, 84 patients showed improvement in clinical condition in the ICU and were released either to the intermediate ward, to the medical department or to complete treatment at home. 58 of them were still showing consolidation (69.06%), 10 patients (11.90%) showed effusion, and 16 patients (19.05%) showed atelectasis (Table 5).
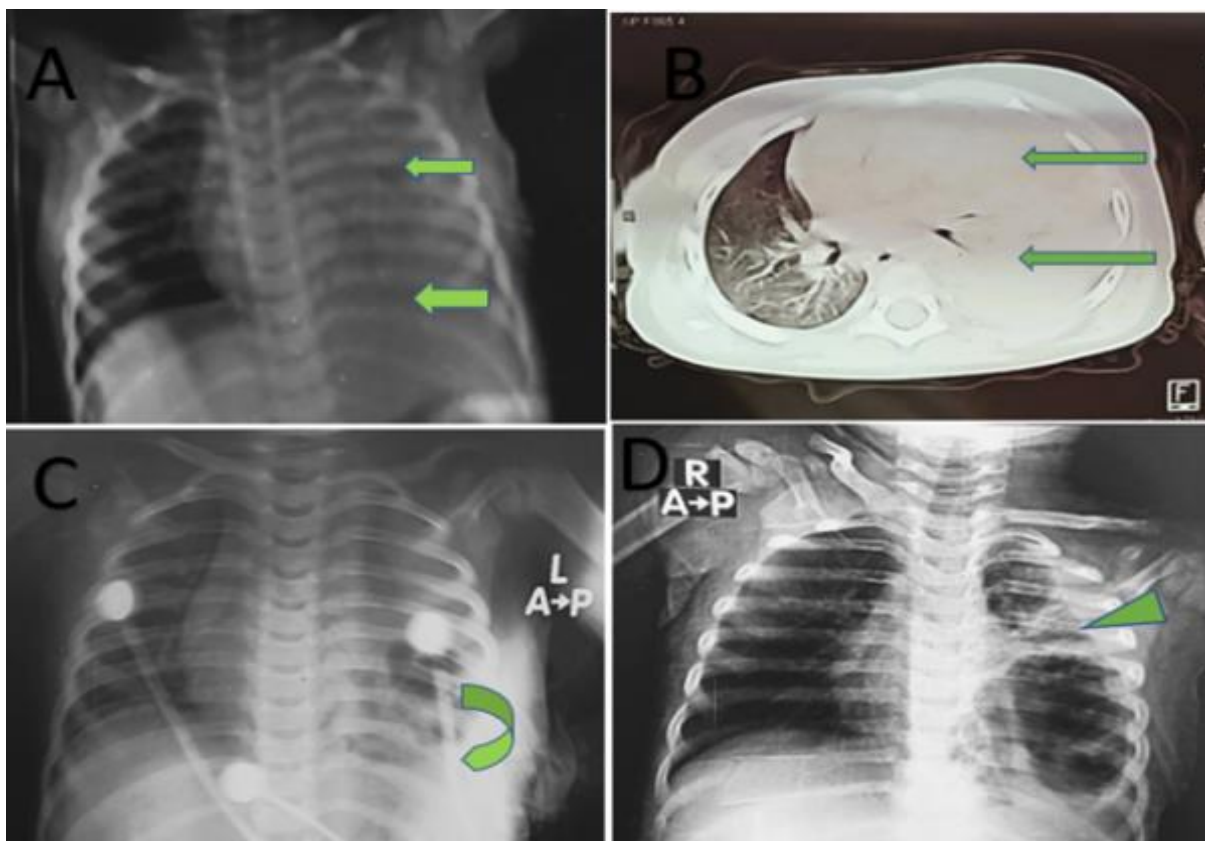

Figure (3): An 18-months-old child complaining of fever and cough with diminished air entry on Lt. lung by examination. 1st chest x-ray (A) total opacification of the left lung (green arrows) the film was hazy due to the patient's unstable condition, (B) CT chest lung window confirmed lung consolidation with pleural effusion, follow up x-ray after chest tube insertion (C) (curved arrow) significant reduction in pleural effusion and lung consolidation, last follow up before ICU release (D) residual lung consolidation (green arrowhead).

Table (4): Change in clinical approach among the studied cases (N=110)

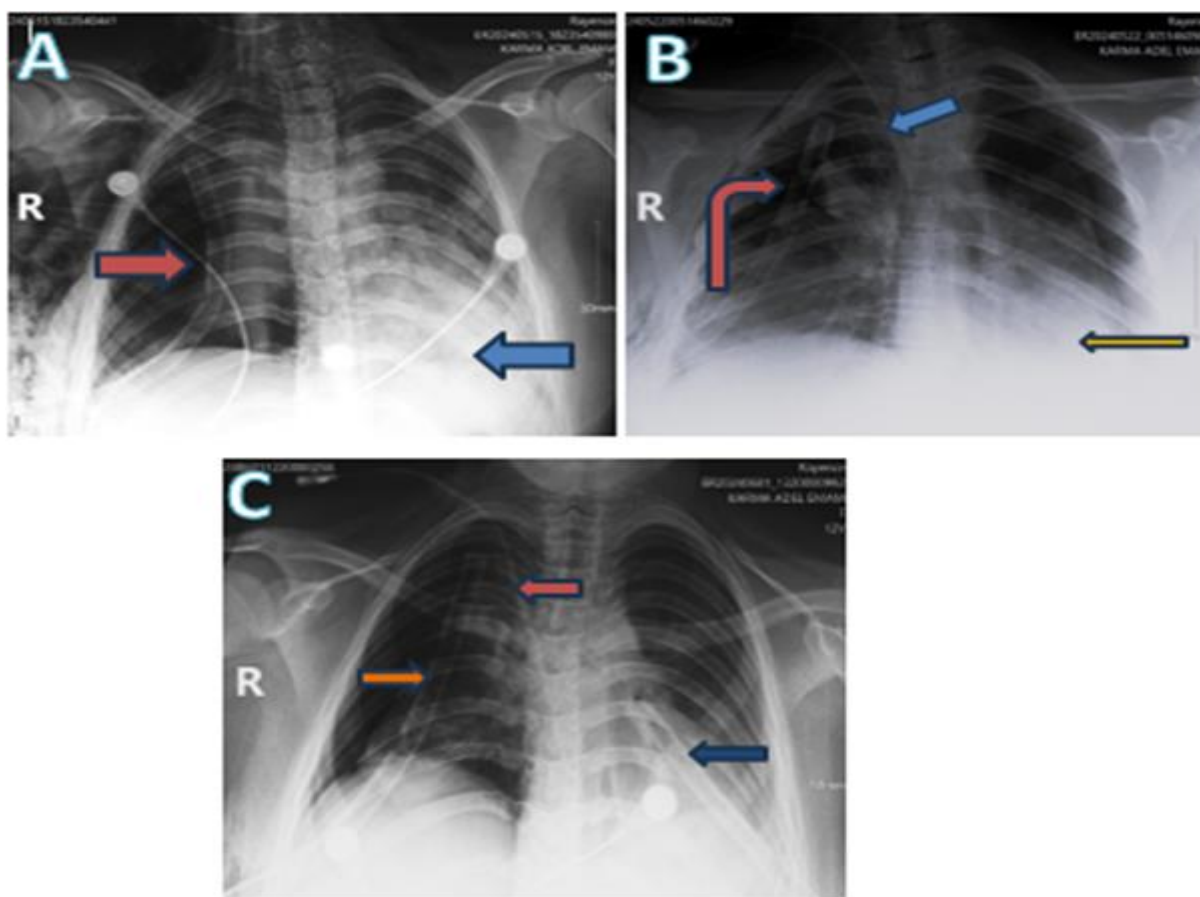| Clinical approach	N	%
Change in management plan (drug therapy)	8	9.52
Requesting more advanced imaging techniques	40	47.62
Repositioning of devices	20	18.2
No change in management plan	30	35.71

Figure (4): A 12-years-old male came to the ER after falling from high. 1st chest x-ray (A) right lung moderate pneumothorax with lung collapse and chest tube seen in place (red arrows) left lung consolidation (blue arrow), follow up x-ray (B) left lung collapse (yellow arrow) and newly developed left pneumothorax (C) after left chest tube (blue arrow), significant reduction in pleural effusion and lung consolidation, the right lung collapse is still not improved.

Table (5): Chest X-ray finding in released cases (N=84)

	Consolidation		Effusion		Atelectasis		Line placement	
	N	%	N	%	N	%	N	%
Released cases	58	69.06	10	11.90	16	19.05	0	0.00

DISCUSSION

Chest radiographs (CXRs) are commonly taken in ICUs. It may be obtained on a daily basis, and radiographs are typically requested without a stated cause [6].

The American College of Radiology Expert Panel agrees that daily routine CXRs are necessary in patients with acute cardiopulmonary issues and those requiring mechanical ventilation [7].

The present study showed that consolidation was the most common at admission (23.62%). In contrast, after line placement, consolidation was the most common chest X-ray finding by 23.6% and in the second follow-up (21.8%) with no significant changes from the initial x-ray chest. Previous study by **Graat *et al.*** [8] reported that a regular chest radiograph is somewhat accurate in identifying lung opacities. And eliminating this common technique revealed no substantial differences in the ICU care or the patient's duration of stay.

In our study, all patients who inserted lines or devices, 20/ 18.2 % of them showed malpositioning of devices.

In this concern, a study by **Al Shahrani and Al-Surimi** [9] found that 96.8% of patients agreed that a chest radiograph is always conducted following endotracheal intubation, 94.5% for insertion of central venous line, 92.9% for placement of chest tube, 86.5% for installation of tracheostomy, and 73% for insertion of a pulmonary artery catheter. These results are in accordance with earlier researches showing that routine daily chest radiographs were mostly taken to determine the location of medical equipment, such as chest tubes and central venous lines, in patients on mechanical ventilation [7, 10, 11].

Additionally, **Al Shahrani and Al-Surimi** [9] discovered that the majority of healthcare providers working in ICUs believed that the existing policy of regular radiography should be discontinued. European referral guidelines state that excessive use of radiological services for imaging raises the danger of

radiation exposure and places a heavy strain on the healthcare system [12]. Regarding the use of regular chest X-rays on a daily basis, there are two schools of thought, and the argument is still open. Since the majority of studies have compared the result efficacy of routine vs restrictive CXR procedures under diverse settings, there is little research on doctors' opinions regarding routine radiography in the intensive care unit (ICU) [13, 14, 15]. Differences in patient populations, enrollment criteria, reliance on radiographic findings, and different definitions of efficacy (e.g., unexpected findings, new findings, or findings leading to treatment changes) are likely the causes of the disparities in efficacy data and opinions regarding the usefulness of routine daily chest radiography [7, 16].

LIMITATIONS: Our study was a single-center study with included small sample size of the studied patients. So, multiple center studies involved a large sample size of patients.

CONCLUSIONS

In our study, consolidation was the most common finding in the x-ray chest at admission, after line placement findings, and first and other follow-up images. The radiographic assessment of the support and monitoring equipment used in ICU patients is critical. Repeated radiographic screening of patients in ICU is recommended for monitoring devices used because the potentially significant complications stemming from their introduction and usage are frequently not clinically obvious. Also, repeated chest X-rays are helpful to detect other serious chest conditions to avoid missed opportunities for imaging when clinically warranted. Additionally, chest X-rays before the patient's release help to anticipate the patient's condition and avoid any unexpected problems after the patient's release.

Conflict of interest: None.
Financial disclosures: None.

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